Processes for manufacturing a paper product from cellulose pulp, part of which comes from a broke and part of which comes from a fresh pulp are provided. The processes involve first redissolving in a broke pulper, with stirring and in an alkaline medium, cellulose fibers contained in said broke to form a broke pulp. Next, the broke pulp is brought to a concentration and a pH close to that characteristic of the fresh pulp by (1) diluting said broke pulp with a white water and (2) acidifying said broke pulp by injecting carbon dioxide into said broke pulp after the broke pulp has left the broke pulper and before admixing said broke pulp with said fresh pulp. Then the broke pulp is admixed with the fresh pulp to form a pulp mixture and the pulp mixture is dewatered to form a paper product and a white water.
PROCESSES FOR PAPER MANUFACTURE, USEFUL FOR INCORPORATING PAPER WASTE REQUIRING A BASIC TREATMENT INTO PAPER PRODUCTS

BACKGROUND OF THE INVENTION

[0001] (I) Field of the Invention

[0002] The present invention relates to improved processes for manufacturing paper products. In particular, the invention relates to processes that incorporate paper waste, which requires a basic treatment, and particularly “brokeds” into paper products.

[0003] (II) Description of the Related Art

[0004] The papermaking process comprises two successive and separate parts. The first part is the preparation of the paper pulp. In this part, the paper pulp is manufactured from various fibrous materials containing cellulose (such as wood and or annual plants) using chemical agents and/or mechanical actions.

[0005] The second part is the manufacture of the paper. The term “paper” denotes a paper product, including but not limited to paper for use in graphics, packaging paper, domestic paper, various special papers, as well as boards and other such products. The terms “paper” and “paper product” will be employed interchangeably in the rest of the text.

[0006] The starting product for this paper manufacture is the paper pulp, i.e., a suspension of fibers in water. To obtain the paper, the fibers are dispersed in water and then worked in order to obtain the desired paper properties in the final product. In particular, the fibers will have to be refined, entangled and dried. During drying, the fibers have the property of adhering naturally to each other.

[0007] Furthermore, various non-fibrous materials, such as fillers, dyes, starches and other auxiliary products, may be fixed to the fibers. This incorporation may take place by addition into the fibrous mat or by deposition on the surface of the paper sheet. The purpose of this incorporation is to give the final product properties particularly suitable for its use.

[0008] When paper pulp is obtained from raw materials (such as wood and various plants), this pulp is usually called “virgin pulp” and may be of the chemical, mechanical, chemimechanical, chemi-thermomechanical type or of another type, depending on the way of the plants and of the mechanical or chemical means employed for obtaining it. It has characteristics associated with its manufacturing process (i.e., pH, presence of additives, etc.).

[0009] The virgin pulp may have been manufactured in the factory where the paper is to be made (i.e., an integrated factory), and thus may be present in the form of a suspension essentially comprising cellulose fibers in water, at a concentration of about 4 to 30% by weight. If the factory does not manufacture the pulp, or if it was stored in an intermediate manner, it may be in the form of bales having dryness generally of about 90%.

[0010] The first operation for paper manufacture will be to put the cellulose fibers into a suspension in water. The purpose of this operation, called “slushing,” is to obtain individual fibers. Slushing is facilitated by the affinity of the fiber for water, which is due to the many hydroxyl (—OH) groups of cellulose.

[0011] The pulp used for manufacturing the paper may also be a recycled pulp. For instance, the pulp may come from the recycling of waste paper, where the waste paper has undergone one or more of the following treatments: pulping, coarse cleaning, de-inking and bleaching steps and other complementary treatments, depending on the use for which the recycled pulp is intended.

[0012] The paper pulp used in the manufacture of paper is mainly one or other of these two types of pulp, or from a mixture of pulps from these two sources, which may comprise various virgin pulps of different types and various recycled pulps of different types. The term “fresh pulp” used in the rest of the text means a mixture of pulps comprising from 0 to 100% virgin pulps and from 0 to 100% recycled pulps.

[0013] In certain manufacturing processes, there is also a third type of pulp that may be added to the other two types of pulp already mentioned. This third type of pulp comes from the reincorporation of scrap paper into the papermaking process, particularly scrap paper from the formation of the paper web. This scrap paper bears the name “broke.” Broke comes especially from web breaks and web trimmings. It may also include papers from various sources, including but not limited to coated papers, uncoated papers, coming from one or more paper machines, as well as scrap paper from various sources.

[0014] In order to be able to reincorporate the scrap paper or broke into the paper process, this scrap paper or broke must undergo a treatment which will be referred to as “broke treatment” in the rest of the description.

[0015] A number of paper manufacturing processes making use of carbon dioxide have been described, including:

[0016] Patent EP 0,281,273, which proposes a process for improving the defibrillation of an alkaline cellulose pulp produced by delignification of a cellulosic material by adding CO₂;

[0017] Patent EP 0,572,304, which describes a process for sizing paper with alkyl ketene dimer, catalyzed by bicarbonate ions generated by adding CO₂;

[0018] International Application WO 98/5988 which combines an alkali metal hydroxide and carbon dioxide in order to buffer a fiber suspension and to produce a paper from the stabilized pulp; and

[0019] Patent Application EP 0,884,416, which describes a process in which an addition of CO₂ is made in order to minimize the addition of aluminium compounds.

[0020] However, none of these processes propose or suggest the use of carbon dioxide as a pH regulator in the broke circuit.

[0021] Additionally, Patent Application EP 0,911,443 recommends the introduction of carbon dioxide into the pulper at the end of the mixing step, in a batch-type broke treatment process. The broke undergoes a high-temperature base treatment in a pulper and is then acidified in one step and diluted in the pulper before being reincorporated into a paper
process. However, it provides no solution to the problem of achieving fine and flexible pH regulation, tailored to the constraints of the various steps of the broke treatment that is easy to implement, both in continuous broke treatments and in batch broke treatments, and at any temperature in the pulper.

Moreover, the addition of carbon dioxide into the pulp in the pulper as described in EP 0,111,443 impairs the precision of the regulations. The acidification with carbon dioxide is carried out in the pulper at the end of the slushing step in alkaline medium. These conditions do not allow satisfactory mixing of the carbon dioxide with the medium to be treated. The acidification thus consumes time and carbon dioxide, for a mediocre result. In addition, it is limited to batch broke treatments.

Accordingly, despite these developments, what is needed in the art is an improved process for paper manufacturing. In particular, what is needed is a process with fine and flexible pH regulation, tailored to the constraints of the various steps of the broke treatment. Such processes should be easy to implement, both in continuous broke treatments and in batch broke treatments, and at any temperature in the pulper.

SUMMARY AND OBJECTS OF THE INVENTION

The present invention relates to processes for producing paper products, where some of the cellulose pulp comes from the recovery of paper waste of the broke or similar kind. The broke may come from the process employed or from any other paper-type process. The present invention provides a solution to the problems associated with conventional broke acidification processes, especially those explained above, and proposes to regulate the pH in the broke treatment by introducing carbon dioxide into at least one point of the broke circuit.

In one embodiment, the invention relates to a process for manufacturing a paper product from cellulose pulp, part of which comes from a broke and part of which comes from a fresh pulp. The process comprises the steps of admixing a broke pulp with a fresh pulp to form a pulp mixture and dewatering said pulp mixture to form a paper product and a white water. The broke pulp is subjected to a broke treatment as follows:

- redissolving, with stirring and in an alkaline medium, cellulose fibers contained in said broke to form a broke pulp,
- bringing said broke pulp to a concentration and a pH close to that characteristic of a fresh pulp by (1) diluting said broke pulp with said white water and (2) acidifying said broke pulp by injecting carbon dioxide into said broke pulp after the step of forming said broke pulp and before admixing said broke pulp with said fresh pulp.

Preferably, the redissolving step is carried out in a broke pulper. Preferably, the admixing step is carried out in a mixing chest. Preferably, the dewatering step takes place in a paper making machine.

In one embodiment, the step of diluting said broke pulp with white water comprises at least two steps of dilution with white water. The process may involve diluting said broke pulp with white water recovered from the paper machine.

In one embodiment, the process may comprise injecting the carbon dioxide into the white water serving for diluting the broke pulp. The process may involve diluting said broke pulp with white water from sources other than said paper making machine, including but not limited to white water coming from preparation of the pulp or clarified water coming from various steps of the process.

In an embodiment, the process of the invention may include introducing carbon dioxide into said broke pulp partly immediately after forming said broke pulp and partly upon completion of the broke treatment. The process may further comprise introducing the carbon dioxide at least two points, i.e., at a first point so as to obtain a suitable intermediate pH during at least one of said deflaking step and said cleaning step, and at a second point located after said broke treatment, so as to have a pH of the diluted broke pulp substantially compatible with the pH maintained in the step of mixing said broke pulp with said fresh pulp.

In one embodiment, during said step of bringing the broke pulp to a concentration and a pH close to that of the fresh pulp, the process according to the invention may further comprise at least (1) deflaking the broke pulp and (2) complementary cleaning of said broke pulp.

In one embodiment, according to the invention, the pH of the diluted broke pulp is between 5.5 and 8.5.

In one embodiment, according to the invention, the intermediate pH of the pulp during at least one of the deflaking step and the cleaning step is between 7.5 and 9, more preferably the intermediate pH is between 8 and 8.5.

In one embodiment, according to the invention, the process may comprise one or more of the following ways of injecting the carbon dioxide:

- into white water fed during said step of forming said broke pulp,
- into white water employed during said diluting step, after formation of said broke pulp,
- into white water after said broke treatment, before mixing with the fresh pulp,
- into the broke pulp after its formation, and before said deflaking or cleaning steps, into the broke pulp, at the end of broke treatment, and before mixing with the fresh pulp.

In one embodiment, according to the invention, the process comprises introducing the carbon dioxide (1) in a white water between the steps of forming said broke pulp and deflaking said broke pulp, so as to obtain a pH of between 7.5 and 9 during said step of deflaking said pulp and (2) in a white water between said step of deflaking said broke pulp and the end of the broke treatment, so as to have a pH of the diluted pulp coming from the broke treatment substantially equal to the pH maintained for mixing the broke pulp with the fresh pulp. The process may comprise introducing the carbon dioxide into the white water between the steps of forming said broke pulp and deflaking said broke pulp so as to obtain a pH of between 8 and 8.5.
The carbon dioxide may be essentially in gas form, essentially in liquid form, or partially in gas form and partially in liquid form.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**FIG. 1** is a schematic illustration depicting the main steps of manufacturing paper from paper pulp;

**FIG. 2** a schematic illustration providing an example of an operation carried out on broke before its reintroduction into the pulp; and

**FIG. 3** is a schematic illustration depicting one particular, but non-limiting, example of a preferred embodiment of the invention.

**DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

In one embodiment, the invention relates to processes relating to the manufacture of paper, i.e., to the process for obtaining the paper product from the paper pulp. As indicated above, the paper pulp is obtained from various cellulosic fibrous materials.

In particular, the invention relates to processes for manufacturing a paper product from cellulose pulp, part of which comes from a broke and part of which comes from a fresh pulp are provided. The processes involve first redissolving in a broke pulper, with stirring and in an alkaline medium, cellulose fibers contained in said broke to form a broke pulp. Next, the broke pulp is brought to a concentration and a pH close to that characteristic of the fresh pulp by (1) diluting said broke pulp with a white water and (2) acidifying said broke pulp by injecting carbon dioxide into said broke pulp after the broke pulp has left the broke pulper and before admixing said broke pulp with said fresh pulp. Then the broke pulp is admixed with the fresh pulp to form a pulp mixture and the pulp mixture is dewatered to form a paper product and a white water.

By injecting the carbon dioxide into the broke pulp, the paper pulp will have left the broke pulper and before admixing the broke pulp with the fresh pulp, the invention avoids certain disadvantages associated with injecting carbon dioxide directly into the broke pulper, such as unsatisfactory mixing of the carbon dioxide with the medium to be treated. Such an approach consumes time and carbon dioxide for a mediocre result.

In addition, by introducing carbon dioxide at one or more points in the broke treatment circuit, the invention allows for precise pH control along the broke treatment circuit. Thus, using the invention it is possible to optimize the pH of the broke pulp for one or more individual operations along the broke treatment circuit. For example, it may be desirable to carry out the deflaking and/or mechanical slushing operations before having lowered the pH too much, whereas it may be desirable to carry out the refining operations after further lowering of the pH.

The first step of the broke treatment comprises slushing the broke, preferably in the presence of white water coming from various steps in the process and in an alkaline medium, generally at a pH of between 8.5 and 13. This slushing step is carried out in what is conventionally called a broke pulper.

As explained above, the pulp coming from this broke pulper preferably has a concentration of about 15%. This pulp will therefore have to be diluted in order to be brought to a suitable concentration, generally from 3 to 4% in the mixing chest where the cellulose pulp intended to enter the short circuit of the cellulose pulp preparation process is prepared. The mixing of the pulp coming from the broke and of the fresh pulp entering the process takes place preferably, but not necessarily, at this stage of the process.

The pulp coming from the broke pulper will therefore have to be diluted. In general, this dilution is carried out by introducing white water coming from the process in at least one step. This dilution is very often carried out in two steps, as shown in FIG. 2. A larger number of dilution steps may be envisaged without departing from the process of the invention.

In the prior art, an acid such as sulfuric acid is conventionally introduced, preferably immediately after the broke leaves the pulper. This introduction has the drawbacks mentioned above. The addition of carbon dioxide as a pH regulator in the broke treatment, according to the invention, has many advantages over the addition of sulfuric acid, including but not limited to:

- Dissociation of the fillers present in the broke or edgings on coated or sized papers caused by pH shocks due to the strong acid. There is a reduction in the pressure losses and therefore a reduction in the fillers added in the machine, with, in particular:
  - Non-dissociation of the fillers present in the broke or edgings on coated or sized papers caused by pH shocks due to the strong acid. There is a reduction in the pressure losses and therefore a reduction in the fillers added in the machine, with, in particular:
  - Absence of sulfates and therefore of possible corrosion;
  - Fine pH regulation (CO₂ is a weak acid);
  - Processing flexibility (no metering pumps or retention tanks).

In an embodiment, the processes comprise injecting judicious amounts of carbon dioxide directly into the white water of the process serving for diluting the pulp coming from the prior treatment of the broke, makes it possible to achieve all the advantages enumerated above with, in addition, increased efficiency and operational simplicity and flexibility which are also increased, something which constitutes an additional advantage of the present invention over the prior art. In particular, it makes it possible, using different points of introduction of white water into the circuit, to jointly ensure that the pulp consistency and the pH are the best suited for each step of the broke treatment, this being so both for continuous treatments and for batch treatments, whatever the temperature in the pulper.

The invention therefore proposes advantageously to replace the acidification methods of the prior art by introducing carbon dioxide at least one point in the broke treatment circuit after the broke has left the broke pulper, so as to regulate the pH of the pulp during the successive steps of the broke treatment, until bringing it to a desired pH in the mixing chest, preferably close to that of the fresh pulp contained in the chest where the pulp will be introduced at the end of the broke treatment. This pH is generally between 5.5 and 8.5.

The introduction of CO₂ into the broke treatment circuit will be done while taking into account the well-
known effect of the pH on cellulose fibers. Indeed, it proves to be particularly advantageous to carry out the deflaking and/or mechanical slushing operations before having lowered the pH too much, so as not to weaken the fibers too much, made weaker by a more acid medium. This is because in a more acid medium the fibers become harder and brittle. Refining in a more acid medium results in an excess of brittle fibers, resulting from shorter fibers, and generates a considerable amount of fines. However, the energy needed for deflaking decreases proportionally with the drop in pH.

Moreover, refining at excessively high pH values may result in yellowing and reversion of the gloss of bleached fibers.

It will therefore be necessary to find the best compromise by carrying out, if possible, gradual acidification, allowing precise pH control by means of the CO₂ with, if required (too high a pH value), a first regulation after the broke pulper containing the base and a final regulation to the desired pH for the mixture in the mixing chest, in order not to create pH perturbations in the line.

This is why, advantageously, the second step comprises at least two steps of dilution with white water.

According to one particularly advantageous embodiment, the carbon dioxide is injected into the white water serving for diluting the pulp coming from the broke.

Preferably, the white water serving for diluting the pulp coming from the broke comprises the white water recovered from the paper machine and, optionally, the white water from other sources, in particular, white water coming from the preparation of the pulp or clarified water coming from various steps of the process.

Advantageously, the carbon dioxide is introduced at two points at least in the broke treatment circuit, partly at the outlet of the broke pulper and partly at the end of the broke treatment.

Although the carbon dioxide introduction may be carried out at any point between the outlet of the broke base treatment pulper and the step of mixing the pulp coming from the broke with the rest of the cellulose pulp, it is particularly advantageous to carry out this carbon dioxide injection into the water for diluting the pulp coming from the broke. This is because it is well known to those skilled in the art that the introduction of carbon dioxide into a relatively concentrated fiber suspension requires the use of a specific device of the porous plug or static mixer type, intended to disperse and dissolve the CO₂ gas within this fiber dispersion. Because of the very low solids concentration of the white water, the recommended carbon dioxide injection directly into the white water serving for diluting the pulp may be carried out without requiring the use of a specific injection device.

Direct CO₂ introduction into the circuit for diluting and cleaning the pulp coming from the broke at two points in the circuit, one located immediately after the outlet of the broke pulper and the other at the end of the broke treatment, has a further advantage if the second step of the broke treatment comprises a step of complementary slushing and/or deflaking since it allows this step to be carried out at a relatively high pH with the advantages explained above with regard to the resistance of the fibers to the treatment.

According to one particular case of the invention, the second step of the broke treatment comprises at least one step of deflaking the pulp coming from the treatment carried out in the pulper and/or at least one step of complementary cleaning of the pulp.

Advantageously, the carbon dioxide is introduced at at least two points: at a first point so as to obtain a suitable intermediate pH during the steps of deflaking and/or cleaning and at the second point located after the steps and at the end of the broke circuit so as to have a pH of the diluted pulp coming from the broke treatment substantially compatible with the pH maintained in the mixing chest.

In particular, the pH of the diluted pulp coming from the broke treatment is between 5.5 and 8.5

According to one advantageous embodiment of the invention, the intermediate pH of the pulp during the deflaking step 22 and/or during the cleaning steps 21, 23 is between 7.5 and 9 and preferably between 8 and 8.5.

Judiciously, the carbon dioxide is injected at one and/or several of the following points:

- into the white water intended for diluting the broke 18.
- into the white water 20 for dilution at the outlet of the broke pulper 15.
- into the white water 24 for dilution at the end of broke treatment, before mixing with the fresh pulp.
- into the broke pulp, at the outlet of the pulper 15 and before the steps 21 and/or 22 and/or 23.
- into the broke pulp, at the end of broke treatment and before mixing with the fresh pulp.

In particular, the carbon dioxide is advantageously introduced via a first dilution water inlet after the outlet of the broke pulper so as to obtain a pH of between 7.5 and 9, and preferably 8 and 8.5, at the device for complementary deflaking of the pulp, and via a second dilution water inlet located between the outlet of this device and the end of the broke circuit so as to have a pH of the diluted pulp coming from the broke treatment substantially equal to the pH maintained in the chest for mixing the pulp coming from the broke with the rest of the cellulose pulp.

The carbon dioxide may be in various forms. It may be essentially in gas form.

It may be essentially in liquid form. It may be partially in gas form and partially in liquid form.

The diagram given in FIG. 3 shows one particularly advantageous special case of a complete process according to the invention for preparing a paper product, in which process the carbon dioxide is introduced via the white water of the process.

The description which follows is given with regard to this FIG. 3, in which the reference numbers indicated correspond to those used for the description of the devices of the prior art according to the previous FIGS. 1 and 2.

This FIG. 3 shows schematically the broke treatment steps from the introduction of the broke into the broke.
pulper 15 to its re-injection into the mixing chest 2, without seeking to show in this figure all the steps of preparing the paper from the pulp prepared in the mixing chest 2.

[0084] The broke coming from the treatment step in the press section 11 of the paper machine is recovered and introduced into the broke pulper 15 where it is treated in an alkaline medium in the presence of white water coming from various steps of the process. In this broke pulper 15, the broke coming from the press section 11 and possibly from waste from other sources, but themselves also requiring a treatment in an alkaline medium is subjected to a pH of between 9 and 13 in the presence of white water coming from the process. Thus, a pulp is prepared in this broke pulper which generally has a concentration of cellulose fibers of about 15% by weight. Next, this pulp undergoes a first dilution by means of white water coming from the process, into which white water carbon dioxide has been introduced beforehand in order to bring the pulp to a pH generally of about 8 to 8.5, and then this pulp thus diluted is subjected to various complementary treatment steps shown schematically by the block 26. These complementary steps may comprise, in particular, steps such as those described with reference to FIG. 2 of primary cleaning 21, of deflaking 22 and of finer cleaning 23, the cascade of complementary treatments depending in fact on the state of the pulp coming from the broke after the treatment in the broke pulper and on the desired degree of purity.

[0085] Next, the pulp thus treated is subjected to a second dilution by means of white water coming from the process containing carbon dioxide. This white water is introduced into the circuit via the line 24.

[0086] In the diagram shown in FIG. 3, the CO₂ introduced advantageously upstream of the point of separation of the white water intended to carry out the two dilution steps, thereby making it possible to use only a single CO₂ injection.

[0087] As shown in FIG. 3, the white water feed intended for diluting the pulp coming from the prior broke treatment comprises, white water coming from the first step of preparing the paper in the headbox 11 of the paper machine. This water is introduced via the line 18. It also contains other water coming from other steps of the process and introduced respectively via the lines 27 and 28. This is, for example, other white water coming from the pulp-thickening step during its washing, in order to remove the various impurities, and which result in the recovery of the diluted water.

[0088] After the second dilution step, the pulp is brought to a pH of the order of that which it is desired to impose in the mixing chest, for example a pH of 8.0, and to a degree of dilution generally of about 3 to 4%, which dilution is also that produced in the mixing chest 2.

[0089] FIG. 1 is a schematic illustration depicting the main steps of manufacturing paper from pulp pulper. The process described in this figure is presented by way of a non-limiting example and the steps described do not necessarily always follow each other in this order and are not always shown in the process. Likewise, some paper processes make use of steps not described here.

[0090] The process according to the invention largely applies to the various paper processes in which the pulp passes through a circuit called a “short circuit” prior to its entry into the paper machine.

[0091] The process may be schematically separated into two parts: a first part relates to the treatment of the pulp, and is essentially carried out in the short circuit or primary circuit in which the pulp coming from the mixing chest is diluted and cleaned before its entry into the paper machine. The second part of the process is the formation of the web and is carried out in the paper machine. The pulp coming from the short circuit is injected into the paper machine at the front of the machine.

[0092] More specifically, referring to FIG. 1, the pulp, refined beforehand in a refiner 1, is introduced into a mixing chest 2 into which various additional materials are introduced at 3, these including the broke and the adjuvants for manufacturing the pulp, among which are, in particular, starch, sizing agents and fillers.

[0093] The pulp prepared in the mixing chest 2 is then introduced via 4 into the pulp tank 5 where it is stored before being introduced into the circuit called the short or primary circuit for preparing the pulp.

[0094] This short circuit conventionally, but not necessarily, comprises a cleaning step making use of all or some of the following devices or equivalent devices.

[0095] a cyclone, generally of the hydrocyclone type, cleaning device 6;

[0096] optionally, a device intended for removing the gas contained in the diluted pulp in order to improve the homogeneity of the pulp introduced into the headbox of the paper machine, so as not to disturb the formation of the web. These devices are denoted hereafter by deaerator-type device 7.

[0097] a device 8 intended to carry out a final cleaning step for the purpose of removing the last particles. This device is generally referred to as a "screen."

[0098] These three types of device form, with the line 9 for feeding the aqueous pulp diluting vehicle, essential elements of what is conventionally called in the field of the short pulp-treatment circuit, in which circuit the pulp is stored beforehand and possibly stored in the pulp tank is both cleaned and suitably diluted before its introduction into the paper machine 10. The aqueous vehicle is especially formed from white water and recycling water coming from the paper machine 10 and from the dewatering of the pulp in the wet end 11 of the machine 10, which water conventionally represents at least 80% and preferably at least 90% of the vehicle, the balance comprising especially a process water and/or fresh water. In the rest of the specification, the terms “white water” and “aqueous vehicle” will be used indiscriminately to denote the aqueous vehicle described above.

[0099] The head element 11 of the paper machine 10, also called the headbox, delivers a ply of fiber suspension identical over its width.

[0100] The web of paper is then formed by depositing the fibers on a wire; the free water is removed through the wire by gravity and optionally with the aid of vacuum pumps. This water coming from the dewatering of the pulp constitutes what is called the white water, mentioned above, and
is used especially in the pulp dilution operations during the circulation of the pulp in the short circuit defined above.

[0101] This white water contains various fine and varied elements. In particular, it contains a small proportion of cellulose fibers which have not been fixed to the web during formation of the latter.

[0102] After leaving the headbox, the web formed beforehand the headbox penetrates the section 12 of the paper machine, called the press section, where the web is drained to a dryness of the order of 40%.

[0103] This section of the paper machine, formed from the headbox and the press section, constitutes the wet end of the paper machine.

[0104] The paper web then penetrates the drying section 13 of the paper machine where the remaining water is removed by evaporation so as to achieve a dryness greater than 90%, preferably about 95% or higher.

[0105] Optionally, the surface roughness of the web is then corrected in the following sections of the machine.

[0106] Thus, the surface roughness of the web may be corrected, depending on the requirements, by smoothing or calendering, generally carried out by compressing the web between cast-iron rollers. Next, in order to improve the surface finish of the sheet, elements are also deposited on its surface, in particular fine pigments and adhesives contained in a composition called a coating slip. Of course, this coating operation is carried out only for certain applications of the paper, for example for the manufacture of papers intended for stationery or for printing. Shown in FIG. 1 by sections 13 and 14 are the optional sections intended for 15 coating and finishing the sheet. The coating operation is not necessarily carried out on the paper machine itself. It could be performed outside the machine, after the product leaving the paper machine has been smoothed.

[0107] As explained above, it is not unusual to recover the scrap paper, generally called broke, coming especially from the press section of the paper machine and to treat it so as to reincorporate it into the paper process. Such a treatment, which depends in fact on the composition of the broke and on the degree of purification needed, is not shown in detail in the diagram in FIG. 1, where this broke is recovered at 15 in order to undergo a treatment intended to allow it to be re-injected directly into the mixing chest 2. This treatment comprising, when it occurs, recovering the broke and subjecting it to a treatment intended for reincorporating it as a mixture with the fresh pulp initially introduced into the mixing chest, is simply represented by a dotted line in the diagram in FIG. 1.

[0108] When the simple slushing of this waste in water is not sufficient to ensure deliberization sufficient to allow the pulp, after suitable dilution, to be re-injected directly into the mixing chest, a pretreatment is generally carried out in an alkaline medium, in a device conventionally called a “pulper” in which the fiber is slushed in the presence of an alkaline medium which makes it possible to swell and weaken the fibers which soften, thus allowing the fibers to be separated under the action of mechanical stirring.

[0109] However, it is not uncommon, particularly in the case when the treated waste contains flakes of ink, to have the prior treatment in alkaline medium followed by a treatment called deflaking, allowing the flakes of ink to be separated, so as to reduce their size, as well as possibly by various cleaning operations carried out before and/or after the deflaking operation.

[0110] Paper on the machine undergoes surface treatments intended to give the treated paper and board excellent wet strength and oil strength. With respect to the cohesion of the paper, this is obtained by the formation, during drying, of low-energy, but very numerous, hydrogen bonds between fibers.

[0111] The rewetting of the paper, while stirring, is generally sufficient to separate the fibers during the recycling. This operation, called “deliberizing” or “slushing” preferably takes place in a pulper having a low (5%) or moderate (15%) concentration and typically poses no problems for untreated papers (newsprint, for example). However, difficulties may appear as soon as the paper has undergone treatments of the “sizing” type with products intended to limit water penetration or with resins creating water-resistant covalent bonds between the fibers. In the latter cases, it will be necessary to prolong the duration of deliberizing or to make use of chemical agents intended for destroying the covalent bonds between the fibers as well as equipment (deflakers) which fragment, by impact, the pieces of paper (flakes) that have not disintegrated.

[0112] If the papers are too strong, it will not be possible to deliberate them and the fragments of paper which are not deliberized or only poorly deliberized will then be equivalent to contaminants that will have to be extracted from the pulp, thus contributing to a reduction in the materials yield.

[0113] In addition, the deliberizing is inevitably accompanied by a fragmentation of certain contaminants, something which will reduce the effectiveness of their removal. The technological trend, mainly with regard to pulpers operating at medium concentration (15%), in the de-inking field is directed toward meeting the objectives of reducing contaminant fragmentation, of saving energy and of increasing the reactivity of the chemicals used.

[0114] FIG. 2 shows, in more detail, an example of an operation carried out on broke before its reintroduction into the pulp. It is given by way of nonlimiting illustration.

[0115] In the example given in FIG. 2, the broke treatment comprises a prior treatment using sodium hydroxide as well as various other complementary treatments which will be explained in detail with reference to FIG. 2. The broke is then introduced, depending on the treatment that it has undergone, either directly into the mixing chest 2 or into the mixing chest after it has undergone a complementary refining operation in the refiner 1.

[0116] Referring to FIG. 2, it may be seen that the broke coming from the press section 12 of the paper machine 10 is introduced into the broke pulper 15 via the line 16. Also introduced into this pulper is sodium hydroxide via the line 17 as well as a fraction of the white water recovered from the pulp treated in the head section. This introduction is done via the lines 18 and 19 so that a fiber concentration of about 15% is obtained inside the broke pulper.

[0117] On leaving the broke pulper 15, the suspension is then diluted with a fresh introduction of white water via the line 20, so as to bring its concentration to a value of about 8%.
Next, this suspension is subjected to a cleaning operation 21, then to a deflaking operation 22 and finally to a finer cleaning operation 23. However, it should be noted that all these successive operations do not always prove to be necessary, as will become apparent from the rest of the description.

Finally, the fiber suspension is again diluted with a fresh introduction of white water via the line 24 in order to bring it to a concentration generally of about 3 to 4% before introducing it either into the mixing chest 2 or into the refiner 1, where it undergoes a complementary refining operation before introduction into the mixing chest 2.

In practice, the various successive operations described above, for the complementary cleaning and/or deflaking of the pulp coming from the broke treatment in basic medium, do not always prove to be essential. In fact, the treatment depends on the nature of the broke treated and on the degree of purity required for the pulp to be treated in the complete process.

However, the pulp coming from the broke thus obtained, which may or may not have undergone, completely or partly, the cleaning and/or deflaking treatments, is once again mixed with the fresh pulp in a mixing chest. Before being added to the fresh pulp, it is diluted in order to bring its concentration to a value close to that of the fresh pulp into which it is incorporated, i.e., a value of about 3% for example.

Because of these dilutions with water at pH values often greater than 7 and because of the optional addition of chemicals such as sodium hydroxide (the role of which is especially to hydrate and swell the fiber, thus destroying the bonds, and thereby making it possible to reduce the subsequent mechanical slashing which damages the fibers), the pH rises to values greater than those of the fresh pulp.

From time to time, paper manufacturers neutralize this pulp before slashing in a broke-feed storage tank 25; this neutralization is conventionally carried out using sulfuric acid, SO₂ or Al₂(SO₄)₃ with all the problems, especially corrosion, imperfect pH control and sulfate additions, that this entails (sulfates weaken, for example, cellohemic fiber).

Specific embodiments of the invention will now be described through examples. The following examples are offered to illustrate this invention and are not to be construed in any way as limiting the scope of this invention. Unless otherwise stated, all temperatures are in degrees Celsius.

**EXAMPLES**

In these examples, the broke is of the WS (wet strength) type (during the tests reported here, injection of carbon dioxide into the white water have not been carried out).

The objective of the tests were to compare the locations of the carbon dioxide injections into the broke circuit and to evaluate the advantage of substituting sulfuric acid with carbon dioxide according to the process of the invention.

In this particular case, the broke treatment has, in the deflaking step, a loop circuit in which the broke is pumped into the tank 25 and reinjected between 21 and 22 so as to obtain the satisfactory end product; it is then discharged into 2, according to FIG. 2.

**Implementation:**

Test No. 1—Point of CO₂ introduction on the discharge side of the pump for draining the pulper 15;

Test No. 2—Point of CO₂ introduction on the discharge side of the pump for the tank 25 in the loop circuit;

Test No. 3—Point of CO₂ introduction on the intake side of the draining pump for the pulper 15.

**Results:**

Test No. 1

Initial pulp pH of 9.6 (at 15)—metered addition of 6 kg of CO₂ for 4 minutes (draining time=2.30”)—for a final pulp pH after stabilization of 7.3 (at the outlet of the broke circuit).

Test No. 2

Initial pulp pH of 10.9 (at 15)—metered addition of 8.5 kg of CO₂ over 10 minutes—recirculation of the pulp into the deflaker circuit—final pH after stabilization=7.02 (at the outlet of the broke circuit).

Test No. 3

Initial pulp pH of 10.8 (at 15)—metered addition of 9 kg of CO₂ over 230”—final pH after stabilization=7.45 (at the outlet of the broke circuit).

**Analysis of the Results:**

Test No. 3 is a good compromise between industrial use and good dissolving efficiency.

Test No. 3 compared with sulfuric acid:

In the case of 106 liters of 375 g/l NAOH in a 2 ton pulper:

(A) H₂SO₄ consumption per pulper=200 liters diluted 12 times (corresponding to 30 kg of pure H₂SO₄)

(B) CO₂ consumption per pulper=9 kg.

That is a savings of 10 kg of acid per ton of pulp coming from WS broke.

For a treatment estimated at 10,000 tons per year, a savings of approximately 100 tons is thus made.

These tests illustrate the advantage of the process according to the invention which allows, in particular, with easy implementation and requiring no special investment, substantial savings of acid to be made compared with the processes conventionally employed, (saving of 10 kg of acid per ton of WS broke) with, in addition, a reduction in the amount of sulfates in the circuits.

While the invention has been described with reference to preferred embodiments, it is to be understood that variations and modifications may be resorted to as will be apparent to those skilled in the art. Such variations and modifications are to be considered within the purview and scope of the invention as defined by the claims appended hereto.
All of the above-mentioned references are herein incorporated by reference in their entirety to the same extent as if each individual reference was specifically and individually indicated to be incorporated herein by reference in its entirety.

What is claimed is:

1. A process for manufacturing a paper product from cellulose pulp, part of which comes from a broke and part of which comes from a fresh pulp, said process comprising the steps of:

   - redissolving in a broke pulper, with stirring and in an alkaline medium, cellulose fibers contained in said broke to form a broke pulp,
   - bringing said broke pulp to a concentration and a pH close to that characteristic of the fresh pulp by (1) diluting said broke pulp with a white water and (2) acidifying said broke pulp by injecting carbon dioxide into said broke pulp after the broke pulp has left the broke pulper and before admixing said broke pulp with said fresh pulp;
   - admixing the broke pulp with the fresh pulp to form a pulp mixture; and
   - dewatering the pulp mixture to form a paper product and a white water.

2. The process of claim 1, wherein said redissolving step is carried out in a broke pulper.

3. The process of claim 1, wherein said admixing step is carried out in a mixing chest.

4. The process of claim 1, wherein said dewatering step takes place in a paper making machine.

5. The process according to claim 1, wherein said step of diluting said broke pulp with white water comprises at least two steps of dilution with white water.

6. The process according to claim 1, comprising injecting the carbon dioxide into the white water serving for diluting the broke pulp.

7. The process according to claim 4, comprising diluting said broke pulp with white water recovered from the paper machine.

8. The process according to claim 7, comprising diluting said broke pulp with white water from sources other than said paper making machine.

9. The process according to claim 8, wherein said sources other than said paper making machine comprise white water coming from preparation of the pulp or clarified water coming from various steps of the process.

10. The process according to claim 1, comprising introducing carbon dioxide into said broke pulp partly immediately after forming said broke pulp and partly upon completion of the broke treatment.

11. The process according to claim 1, further comprising, during said step of bringing the broke pulp to a concentration and a pH close to that of the fresh pulp, at least one of (1) deflaking the broke pulp or (2) complementary cleaning of said broke pulp.

12. The process according to claim 11, further comprising introducing the carbon dioxide at least at a first point so as to obtain a suitable intermediate pH during at least one of said deflaking step and said cleaning step, and at a second point located after said broke treatment, so as to have a pH of the diluted broke pulp substantially compatible with the pH maintained in the step of mixing said broke pulp with said fresh pulp.

13. The process according to claim 1, wherein the pH of the diluted broke pulp is between 5.5 and 8.5.

14. The process according to claim 12, wherein the intermediate pH of the pulp during at least one of the deflaking step and the cleaning step is between 7.5 and 9.

15. The process according to claim 14, wherein the intermediate pH is between 8 and 8.5.

16. The process according to claim 11, comprising injecting the carbon dioxide:

   - into white water fed during said step of forming said broke pulp,
   - into white water employed during said diluting step, after formation of said broke pulp,
   - into white water after said broke treatment, before mixing with the fresh pulp,
   - into the broke pulp after its formation, and before said deflaking or cleaning steps, or
   - into the broke pulp, at the end of broke treatment, and before mixing with the fresh pulp.

17. The process according to claim 11, comprising introducing the carbon dioxide (1) in a white water between the steps of forming said broke pulp and deflaking said broke pulp, so as to obtain a pH of between 7.5 and 9 during said step of deflaking said pulp and (2) in a white water between said step of deflaking said broke pulp and the end of the broke treatment, so as to have a pH of the diluted pulp coming from the broke treatment substantially equal to the pH maintained for mixing the broke pulp with the fresh pulp.

18. The process according to claim 17, comprising introducing the carbon dioxide into the white water between the steps of forming said broke pulp and deflaking said broke pulp so as to obtain a pH of between 8 and 8.5.

19. The process according to claim 1, wherein the carbon dioxide is essentially in gas form.

20. The process according to claim 1, wherein the carbon dioxide is essentially in liquid form.

21. The process according to claim 1, wherein the carbon dioxide is partially in gas form and partially in liquid form.